SPANNING MEMBER WITH CONVOLUTED WEB, C-SHAPED FLANGES, AND END PLATE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to spanning or beam members and, more particularly, to beam members formed of a pair of opposing C-shaped flanges, a convoluted web for added strength, and an end plate for structurally protecting and interconnecting the beam members.

2. Background of the Art

Beam members are widely used in the construction industry, not only as a permanent building elements but also as a part of construction formwork, such as in scaffolding, concrete forms, and the like. An example of beam members used in formwork include the soldier described in U.S. Pat. No. 4,964,256, which is used as upright and horizontal structural members, inclined braces, columns, shores, and walers. Another example is the lightweight steel beam member used as a support for decking or sheeting as a part of a concrete forming system, as described in U.S. Pat. No. 5,307,601. These beam members are also used as metal studs and other building components where they substitute for conventional dimensional lumber.

Such beam members are made in a wide variety of shapes and designs and of a wide variety of materials. With the widespread use of roll-forming techniques, it has become increasingly common to use beam members that are made of metal sheet material formed primarily by roll-forming to create relatively lightweight yet strong beam members. One way to achieve desired efficiencies and reduce the cost of the beam member is through the use of thinner

metal sheet material in the roll-forming process, provided that the resultant beam member is designed to retain the desired strength and other characteristics. The thinner sheet material is less expensive, easier and cheaper to roll-form, and lighter in weight.

In the context of construction formwork, the beam members typically rest on top of support posts (mono-posts™). While the beam members vary in length, normally the beams must interconnect to span the required length. Commonly, the interconnection consists of a collar that secures around the overlapped ends of two beams. This point of interconnection typically requires a separate support post, since the connection usually comprises a weak point. Overlapping the beam members can help to alleviate this problem but this requires using either more beam members, or longer beam members. Additionally, similar problems occur with beam members used in permanent building construction. This system of interconnection generally adds an undesirable level of complexity, requires more support posts, and the interconnection sites constitute a potential point of failure in the support system.

SUMMARY OF THE INVENTION

The invention consists of a beam member that has a pair of longitudinally extended and opposing flanges each of which includes a central web section and a pair of inwardly extended leg sections such that each flange is generally C-shaped in transverse cross section. A longitudinally extended web member is interposed between the opposing pair of flanges and has a pair of longitudinally extended sides each of which is in contact engagement along the central web section of a corresponding one of said pair of opposing flanges. The web member has one or more convoluted sections with alternating lateral protrusions that extend transversely across

the width or height of the web. The protrusions extend laterally to be adjacent along a portion of a corresponding opposite pair of said leg sections of the flanges. The sides of the web are welded to the flanges at the central web section thereof and the protrusions of the web are welded to the adjacent portions of the leg sections of the flanges. An end plate secures to the opposing flanges and to the web member interposed therebetween, providing a superior means for interconnecting the beam members. The resultant beam member may be manufactured out of relatively thin sheet material and yet have a high stiffness and weight bearing capacity before crushing.

An object of the present invention is to provide a beam member for use in concrete forming apparatus and also as a building component that will form a permanent part of the constructed building.

Another object of the invention is to provide a beam member with a convoluted web that is roll-formed from a sheet of metal material and having improved stiffness and resistance to crushing under load.

A further object of the invention is to provide a beam member having a corrugated web welded to a pair of opposing flanges that are either U-shaped or C-shaped in transverse cross section to comprise a beam member having improved stiffness and resistance to crushing under load.

Still another object of the invention is to provide a metal beam member that can be used as a replacement for dimensional lumber and includes flanges that are penetrable by screws or hand-driven nails.

Yet another object of the invention is to provide a beam member that can readily interconnect with like beam members.

These and other objects of the invention will become apparent from a review of the following specification, attached drawings, and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an elevational side view of a beam member of the present invention.

Fig. 2 is a top plan view of the beam member of Fig. 1.

Fig. 3 is an end view of the beam member of Fig. 1.

Fig. 4 is an enlarged detail view showing weldments securing a web of the beam member to flange members of the beam member.

Fig. 5 is a top plan view of the flange member of the present invention.

Fig. 6 is an end view of the flange member of Fig. 5.

Fig. 7 is a top plan view of the web the present invention.

Fig. 8 is a side elevational view of the web of Fig. 7.

Fig. 9 is a perspective view of an end plate of an ~~alternative~~ improved beam member.

Fig. 10 is a top plan view of an ~~alternative~~ improved flange member with relief lines.

Fig. 11 is a partial perspective view of the ~~alternative~~ improved flange member of Fig. 10.

Fig. 12a-b are end views of the ~~alternative~~ improved beam member.

Fig. 13 is a cross-sectional view of the ~~alternative~~ improved beam member of Fig. 12b taken along the line 13 -- 13 shown in Fig. 12b.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Illustrated in Figs. 1 – 4, generally at 10, is a beam member having a pair of opposing flanges 12 and 14. Interposed between the opposing flanges 12 and 14 is a web 16 which, as best illustrated in Fig. 7, has a plurality of alternating, transversely extended protrusions, with the protrusions extending laterally to a first side of the web 16 identified with the reference numeral 18a and the protrusions extending laterally to a second side of the web 16 identified with the reference numeral 18b (see Fig. 2).

The flanges 12 and 14 are identical, each including a longitudinally extended central web section 20 and a pair of leg sections 22 and 24 that are extended inwardly from either side of the central web section 20 (Figs. 5 and 6). In the preferred embodiment, the free end portions 26 and 28 of the leg sections 22 and 24, respectively, are turned toward each other so that the flanges 12 and 14 are generally C-shaped in transverse cross-section.

The web 16 is formed of a rectangular sheet that has been bent along transverse lines perpendicular to the longitudinal axis of the sheet. The bends, indicated at 30 in Fig. 8, alternate in direction at intervals to produce at least a section of the web 16 having a convoluted or corrugated shape wherein the protrusions 18a and 18b extend to either side of the web 16 (Fig. 7). In the preferred embodiment, the protrusions 18a and 18b are symmetrical and have flat outer sections 32a and 32b, respectively, that are laterally spaced by a distance that matches the transverse distance or spacing between the free end portions 26 and 28 of the leg sections 22 and 24 of the flanges 12 and 14. Accordingly, upon assembly of the web 16 and flanges 12 and 14, the flanges 12 and 14 will fit over the longitudinally extended sides of the web 16 with the side

edges of the web 16 in flush contact engagement with the central web section 20 of each of the flanges 12 and 14 and with the flat outer sections 32a and 32b of the protrusions adjacent the free end portions 26 and 28 of the flange leg sections 22 and 24 (Fig. 3).

To complete the beam member 10, the flanges 12 and 14 are preferably welded to the web 16. As illustrated in Fig. 4, the flat outer sections 32a and 32b of the protrusions 18 are welded at 34 to the free end portions 26 and 28 of the flange leg sections 22 and 24, and the side edges of the web 16 are welded at 36 to the central web section 20 of each of the flanges 12 and 14. In the resulting assembly, the convoluted web 16 provides stiffened members over the points of support to resist crushing of the beam member 10 under load resting on the top flange. In addition, the inwardly extended leg sections 22 and 24 permit welding to the web 16 at points inward of the central web section 20 to reduce the unbraced and unstiffened size of the compression elements to allow the use of thinner metal sheet material in the manufacture of the beam member 10.

In the preferred embodiment, the protrusions 18 are formed using alternating bends of approximately 120°, with the flat sections 32 of a length of 62.5 mm separated by 73 mm. This results in a corrugated web 16 that has an outside lateral width of 65 mm. The flanges 12 and 14 are formed using 90° bends with a central web section 20 of 89 mm in width, wherein the leg sections 22 and 24 extend transversely inwardly 36 mm and the free end sections 26 and 28 extend laterally inwardly 12 mm so that the gap between opposing free end sections is 65 mm. The web 16 are roll-formed from high strength, low alloy sheet steel having a thickness of .0598 inches (16 gauge) and the flanges 12 and 14 are roll-formed from high strength, low alloy sheet steel having a thickness of .0747 inches (14 gauge). The beam member 10 can vary in length,

with the preferred lengths ranging from 1.2 m to 7.2 m, in increments of .6 m. A beam member 10 with these dimensions is suitable for use as a replacement for 3½ inch wide lumber in garage door headers, window headers, and other long spanning applications in residential construction. In one embodiment of the present invention the flanges 12 and 14 are of sufficient thickness to allow for penetration by screws or hand-driven nails for the attachment of other building components as with lumber. The beam members are also intended for use in the concrete forming industry where they are used to support concrete forms in horizontal forming applications. Beam members of the present invention will generally serve as an intermediary supporting member between other components of concrete forming systems apparatus.

Although the preferred embodiment has been described as having the web and flanges manufactured from specified sheet material, sheet materials of different thickness or other characteristics may be used depending on the desired performance characteristics of the resulting beam member. Additionally, while the protrusions or corrugations of the web in the preferred embodiment are comprised of straight or flat sections made by a series of bends across the full transverse width of the sheet, other diverse convolutions could be used. Additionally, in the preferred embodiment, the convoluted section extends the full length of the web, whereas it may be desirable to provide one or more convoluted sections that are less than the full length. Further, while flanges of a generally C-shape are used in the preferred embodiment, flanges of a U-shaped cross section could be employed, albeit with some loss in strength and possible added material costs.

Figs. 9-12 show an ~~alternative~~ improved embodiment of the present invention. In particular, Figs. 12a and 12b shows a beam member 50 that includes a endplate 52 (see Fig. 9) with circular

perforations 51. The beam member 50 also includes a recessed pair of opposing flanges 54. The flange 54 generally operates in a similar manner to the flange 12 shown in Fig. 6. The flange 54 contains a longitudinal extending central web section 60, and a pair of interconnected leg sections 58, 62 that extend inwardly from either side of the central web section 60. Additionally, free end portions 56, 64 turn toward each other extending away from the leg sections 58, 62. In this manner, the flange 54 forms a generally C-shape in transverse cross-section.

In contrast to the free end portions 26, 28 of flange 12, the free end portions 56, 64 of the flange 54 are recessed away from the top of the leg sections 58, 62. Shown best in Figs. 10 and 11, the recessed areas 66 form a ledge for receipt of the end plate 52. In other words, where the free end portions 26, 28 of the flange 12 extend to meet the leg sections 22, 24 flush, the free end portions 56, 64 of the flange 54 do not extend all the way up to meet the leg sections 58, 62. Figs. 12a and 12b show this configuration in phantom, the free end portions 56, 64 extend under the end plate 52 (see phantom lines).

In the preferred embodiment, the end plate 52, rests on the ledge formed by the recessed free end portions 56, 64 such that the recess 66 extends to a depth to receive one-half of the thickness of the end plate 52. This allows for the end plate 52 to securely seat within the flange 54, while still allowing the end plate 52 to protrude sufficiently above the flange 54 to allow for achieving a secure attachment through fillet weldments 68 (Fig. 12b). The end plate 52 secures to both the flange 54 and the web 16. Fillet welds 68 secure the end plate 52 to the flange 54 along the entire length of the intersection of the two components. Additionally, interior welds secure the end plate 52 to the web 16. Fig. 12. shows the orientation of the underlying web 16 in phantom. The web 16, in the orientation shown in Figs. 12a and 12b, underlies the end plate 52.

Intermittent fillet welds along the interior underlying interface of the end plate 52 and the web 16 secure the components in place.

Fig. 13 shows a cross-sectional view of the beam member 50 showing the interface between the end plate 52, the flange 54, and the web 16. Again, the end plate 52 rests on the ledge created by the opposing recessed free end portions 56, 64 of the flange 54. The recess preferably allows about one-half of the thickness of the end plate 52 to protrude above the flange 54. This provides sufficient area for well securing weldments 68, and also allows the end plate 52 to seat within the flange 54. In this manner, the present invention achieves a full moment connection between the end plate 52 and the flange 54.

The end plate 52 measures approximately 224 mm in length along a longitudinal axis, approximately 84 mm in width along a transverse axis, and approximately 7 mm in thickness. The perforations 51 are separated by approximately 150 mm, and are evenly centered thereabout. The perforations 51 measure approximately 20 mm in diameter. Those of ordinary skill in the art will appreciate the fact that the exact dimensions and materials described herein can vary without departing from the scope of the present invention. Additionally, the Figures are not necessarily drawn to scale, but are exaggerated in places in order to more readily depict the features of the present invention. For example, the recessed areas 66 shown in Fig. 11 are exaggerated for illustrative purposes.

The advantage of this embodiment comprises the fact that the beam member 50 can interconnect with other beam members 50 through, for example, bolts secured through the circular perforations 51 in the end plate 52. This eliminates the need for the overlapping connection and securing collars used in the prior art. The beam members 50 provide a superior

end connecting means by creating a full moment connection between beam members 50. Additionally, the end plates 52 provide protection for the free end of the beam members 50 from normal wear and tear damage that occurs at the ends of the beam members 50 from moving, securing, and removing the beam members 50.

Although the invention has been described with respect to a preferred embodiment thereof, it is to be also understood that it is not to be so limited since changes and modifications can be made therein which are within the full intended scope of this invention as defined by the appended claims.